## REMARKS

Claims 1-52 and 54-94 are currently pending. Claims 1, 3, 4, 15, 20, 25, 27, 28, 30, 36, 43, 44, 46, 49, 50, 67, 69, 78, 81-83, 91, and 94 are amended herein.

Claims 1, 25, 44, 67, and 82 are amended to clarify the process conditions of step (ii) to recite that the reaction between the group VIA1 element and the metals of the mixture of the metal film is incomplete. Claims 36, 43, 78, 81, 91, and 94 are amended to further clarify the recited formulas. Claims 3, 4, 15, 20, 27, 28, 30, 46, 49, 50, 69, and 83 are amended to further clarify the recited processes. Claim 82 is also amended to be an independent claim. Support for the amendments can be found throughout the claims and specification as filed, for example paragraphs [0028], [0062], [0069], [0083], [0201], [0218], [0220], and [0221] of the specification as published.

New Claims 95-100 are added. Support for the new claims can be found throughout the specification, for example paragraphs [0061], [0062], [0110], [0141], [0216], [0222], [0232], [0233], [0245], [0267], [0276], and [0277] of the specification as published. No new matter is added.

Applicant submits that this application is in condition for allowance and such action is earnestly requested. Each of the Examiner's reasons for rejection is addressed below.

**Rejections under 35 U.S.C. § 112**

Claims 1-94 stand rejected under 35 U.S.C. § 112, second paragraph, as indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Without acquiescing in the rejection, Claims 1, 3, 15, 20, 25, 27, 28, 30, 36, 43, 44, 46, 49, 67, 69, 78, 81-83, 91, and 94 are amended herein to further clarify and more positively recite certain features. Accordingly, Applicant respectfully requests withdrawal of this rejection.

**Rejections under 35 U.S.C. § 102**

Anticipation under Section 102 can be found only if a reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775 (Fed. Cir. 1985). More particularly, a finding of anticipation requires the disclosure in a single piece of prior art of each and every

limitation of a claimed invention. *Electro Med. Sys. S.A. v. Cooper Life Sciences*, 34 F.3d 1048, 1052 (Fed. Cir. 1994).

Applicants also note that "[i]nherency, however, may not be established by probabilities or possibilities. The fact that a given thing ***may*** result from a given set of circumstances is not sufficient." *In re* Oelrich, 212 U.S.P.Q. 323, 326 (C.C.P.A. 1981). *See also* Tintec Industries, Inc. v. Top-USA Corp., 63 U.S.P.Q.2d 1597, 1599 (Fed. Cir. 2002). When relying upon the theory of inherency, the Examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic ***necessarily flows*** from the teachings of the applied prior art. *Ex parte* Levy, 17 U.S.P.Q.2d. 1461, 1464 (Bd. Pat. App. & Inter. 1990)(emphasis added).

**The Applicant's Background Section Does Not Anticipate Claims 1-7, 9-10, 15, 18, and 19**

Claims 1-7, 9-10, 15, 18, and 19 stand rejected under 35 U.S.C. § 102(b) as anticipated by the Applicants Background Section.

Claim 1 is amended herein to recite in part "(ii) heat treating the metal film in the presence of a source of a first group VIA element, said first group VIA element being hereinafter referred to as $VIA_1$, ***under such conditions that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete*** and a first film is formed comprising a mixture of at least one binary alloy selected from the group consisting of a group IB-$VIA_1$ alloy and a group IIIA-$VIA_1$ alloy; and at least one group IB-IIIA-$VIA_1$ ternary alloy". Thus, the reaction between the group $VIA_1$ element and the metals of the mixture is incomplete such that there is at least one binary alloy present in the mixture after this step. The cited art fails to explicitly or inherently disclose this feature. Accordingly, Applicant respectfully request withdrawal of this rejection.

The cited art cannot anticipate Claim 1 and its dependents because it does not teach all of the limitations, as required. Accordingly, Applicant respectfully requests withdrawal of this anticipation rejection.

**Nagoya Does Not Anticipate Any Claims**

Claims 1-8, 13-21, 23-24, 26-31, 35-37, 40-41, 48, 44-46, 49-54, 61-66, 67, 70, 74, 78, 82, 84-86, 90-91 stand rejected under 35 U.S.C. § 102(b) as anticipated by Nagoya ("Role of incorporated sulfur into the surface of $Cu(InGa)Se_2$ thin-film absorber" 2001, hereinafter Nagoya). Applicant respectfully disagrees.

Nagoya discloses that "[h]igh-performance $Cu(InGa)Se_2$ (CIGS) thin-film absorbers with an ***intentionally graded*** band-gap structure have been fabricated by a simple two-stage method using In/Cu-Ga/Mo stacked precursors and $H_2Se$ gas." Abstract (emphasis added).

The graded film structure results in most of the gallium residing at the back of the film. Thus, the absorber film exhibits a low band gap value in the active region of the photovoltaic cell. This ultimately limits the performance of the device. *See* paragraph [0014] of the specification as published. A number of disadvantages of the traditional two step process are disclosed in paragraphs [0018]-[0023] of the specification as published.

In the post-sulphurization process the object is to replace the Se species with S in the near surface region of the alloy, where the absence of Ga is preventing the widening of the optical band gap of the semi-conductor material restricting the operating parameters of the photovoltaic devices in which it is utilized. In theory, this process should result in the shrinkage of the lattice parameters (replacement of large Se atom with smaller S atom), which in turn would result in an increase in the optical band gap.

Nagoya conducted low temperature photoluminescence (PL) studies on the compounds to evaluate the optical properties and possible shifts in band gap due to incorporation of Ga and S into the $CuInSe_2$ lattice of quaternary alloys. Nagoya discloses that "[a]s shown in Fig 6, all the PL spectra were quite similar to that of $CuInSe_2$ (CIS) absorber at about 1340nm (0.925eV) [4.5]. This indicated that in the measured region of CIGS absorber with a thin CIGSS surface layer there were no effects of wider band gap by S, although AES measurements confirmed that sulfur distribution adjacent to the surface was observed". Pages 250-251. Nagoya further discloses that "[a]s seen in Figs 4 and 5, it was verified to be possible to incorporate more S into the CIGS absorber by adjusting the absorber formation process but difficult to improve the device performance with higher S contained CIGS absorber". Page 251; FIGS. 5 and 6 (emphasis added). Nagoya therefore discloses that although Ga (25 wt %) and S (10-20%) were

incorporated into the $CuInSe_2$ alloy, the lattice parameters and hence the optical band gap of the alloys were not altered.

Applicants respectfully disagree with the rejections because the cited art fails to disclose the recited process steps. Nevertheless, independent Claim 1 is amended herein to recite in part "(ii) heat treating the metal film in the presence of a source of a first group VIA element, said first group VIA element being hereinafter referred to as $VIA_1$, ***under such conditions that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete*** and a first film is formed comprising a mixture of at least one binary alloy selected from the group consisting of a group IB-$VIA_1$ alloy and a group IIIA-$VIA_1$ alloy; and at least one group IB-IIIA-$VIA_1$ ternary alloy". Nagoya fails to disclose this feature explicitly or inherently because the process conditions in Nagoya are such that the selenization is complete and the binary alloys are consumed.

Moreover, the selenization conditions of Nagoya are such that the substrate is fully selenized, i.e. all the available binary metal selenides are reacted to form separate stable ternary alloys of $CuInSe_2$ and $CuGaSe_2$. Declaration of Vivian Alberts, Paragraph 6. Thus substantially all of the binary selenides (CuSe, InSe) are consumed. Declaration of Vivian Alberts, Paragraph 6. Thus, Nagoya fails to disclose, explicitly or inherently, a process wherein the reaction conditions are controlled such that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete.

Independent Claim 44 is amended herein to recite in part "(ii) heat treating the metal film in the presence of a source of a first group VIA element, said first group VIA element being hereinafter referred to as $VIA_1$ ***under such conditions that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete*** and a first film is formed comprising a mixture of at least one binary alloy selected from the group consisting of a group IB-$VIA_1$ alloy and a group IIIA-$VIA_1$ alloy; and at least one group IB-IIIA-$VIA_1$ ternary alloy, wherein the mixture is a stable mixture such that the molar ratio of all the group IB-$VIA_1$ and/or group IIIA-$VIA_1$ alloys to the at least one group IB-IIIA-$VIA_1$ ternary alloy remains substantially constant". Nagoya fails to disclose this feature explicitly or inherently.

Independent Claim 82 is amended herein to recite in part "(ii) comprises heat treating the metal film of step (i) in the presence of a source of $VIA_1$ ***under such conditions that the***

***reaction between the group VIA$_1$ element and the metals of the mixture of the metal film is incomplete*** and a first film is formed comprising a mixture of binary alloys selected from the group consisting of a group IB-VIA$_1$ alloy, a group IIIA-VIA$_1$, and a ternary alloy being a group IB-IIIA-VIA$_1$ alloy". Nagoya fails to teach this feature explicitly or inherently.

Nagoya cannot anticipate Claims 1, 44, or 82 and their dependents because Nagoya does not teach all of the limitations recited in the claim, as required. Accordingly, Applicant respectfully requests withdrawal of this anticipation rejection.

**Rejections under 35 U.S.C. § 103**

It is well settled that the Examiner "bears the initial burden of presenting a *prima facie* case of unpatentability..." *In re Sullivan*, 498 F.3d 1345 (Fed. Cir. 2007). Until the Examiner has established a *prima facie* case of obviousness, the Applicant need not present arguments or evidence of non-obviousness. To establish a *prima facie* case of obviousness, the Examiner must establish at least three elements. First, the prior art reference (or references when combined) must teach or suggest all of the claim limitations: "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 165 U.S.P.Q. 494, 496 (CCPA 1970); *see also M.P.E.P. § 2143.03*. Second, there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091, 231 U.S.P.Q. 375 (Fed. Cir. 1986); *Pharmastem Therapeutics v. Viacell, Inc.*, 491 F.3d 1342, 83 U.S.P.Q.2d 1289 (Fed. Cir. 2007); *see also M.P.E.P. § 2143.02*. And finally, the Examiner must articulate some reason to modify or combine the cited references that renders the claim obvious. Merely establishing that the claimed elements can be found in the prior art is not sufficient to establish a *prima facie* case of obviousness:

> As is clear from cases such as *Adams*, a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007) (emphasis added).

Instead, the Court has made clear that the Examiner must establish a reason one of skill in the art would have combined the elements of the prior art, and that such reason must be more than a conclusory statement that it would have been obvious.

> Often, it will be necessary for a court to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. To facilitate review, this analysis should be made explicit. *See In re Kahn,* 441 F.3d 977, 988 (C.A.Fed.2006) ("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness"). *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1740-1741 (2007).

Each of the combinations asserted by the Examiner is addressed below.

**Nagoya Does Not Make Any Claims Obvious**

Claims 9-12, 22, 31, 33, 34, 38-39, 47, 55-58, 71-75, 76, 79-80, and 87-88 stand rejected under 35 U.S.C. § 103 as unpatentable in view of Nagoya.

The Examiner found that a number of the features recited in the dependent claims would have been obvious to the skilled artisan. Office Action, pages 10-12. Applicant respectfully disagrees for the reasons discussed below.

**Nagoya Fails to disclose the features of Independent Claims 1, 44, and 82**

First, as discussed above, Nagoya fails to disclose the features of independent Claims 1, 44, and 82. The features of Claims 1, 44, and 82 are more than obvious variations of Nagoya.

As discussed above, the selenization conditions of Nagoya are such that the substrate is fully selenized, i.e. all the available binary metal selenides are reacted to form separate stable ternary alloys of $CuInSe_2$ and $CuGaSe_2$. Declaration of Vivian Alberts, Paragraph 6. Thus substantially all of the binary selenides (CuSe, InSe) are consumed. Declaration of Vivian Alberts, Paragraph 6. Therefore, Nagoya fails to disclose explicitly or inherently, or make obvious a process wherein the reaction conditions are controlled such that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete.

Further, there is no reason that the skilled artisan would modify the disclosure of Nagoya to modify the selenization conditions to arrive at the features recited in independent Claims 1, 44,

and 82, especially because Nagoya failed to successfully modify the band-gap properties of the resulting alloy by incorporating various amounts of sulfur. *See* Nagoya pages 250-251.

**No Reasonable Expectation of Success**

Second, one skilled in the art would have no reasonable expectation of success to modify Nagoya to arrive at the features recited in the pending claims. *Pharmastem Therapeutics v. Viacell, Inc.* 491 F.3d 1342, 83 U.S.P.Q.2d 1289 (Fed. Cir. 2007) (after *KSR*, Federal Circuit finds claims non-obvious for lack of indication of reasonable expectation of success for asserted combination). Further, "[t]o the extent that an art is unpredictable, as the chemical arts often are, *KSR*'s focus on these 'identified, predictable solutions' may present a difficult hurdle because potential solutions are less likely to be genuinely predictable." *Eisai Co. Ltd. v. Dr. Reddy's Laboratories, Ltd*, Nos. 2007-1397, -1398, slip opinion at pg 8 (Fed Cir. 2008).

As discussed above, Nagoya fails to disclose a process where the reaction conditions are controlled such that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete.

Further, the properties of the alloy formed by the methods disclosed in this application were able to be controlled to modify the band-gap and lattice constant to deposit alloys of desired properties. Nagoya clearly discloses that the two stage processes only produced a ***heterogeneous graded*** CIGS absorber with a thin CIGSS surface layer. Declaration of Vivian Alberts, Paragraphs 5-6. Further, the additional incorporation of sulfur did not result in improved device performance or increased band-gap properties. *See* Nagoya, pages 250-251. The bulk lattice parameters of the alloy were not influenced by addition of Ga or S. Despite considerable efforts and cost to introduce additional Group III and VI elements into the ternary alloy $CuInSe_2$, the optical band gap value remained unchanged and still represented the band gap value (and hence lattice parameters) of the ternary alloys.

Thus, there is no reasonable expectation of success to modify Nagoya to arrive at a process wherein the reaction conditions are controlled such that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete.

Applicants also respectfully disagree with some of the Examiner's other findings. For example, the Examiner found that "it would have been obvious to optimize the temperature from 480 to 520 degrees. One would have been so motivated in order to improve/optimize the material properties" and that "it would have been obvious to have optimized the temperature from 500-580 degrees." Office Action page 11. Applicant respectfully disagrees.

There is no indication in Nagoya that temperature is a result effective variable as Nagoya was unsuccessful in modifying the band-gap of the resulting alloy for all of the various processing temperatures and conditions employed. The skilled artisan would have had no reason or reasonable expectation of success to modify Nagoya to arrive at the features recited in the claims for at least this reason.

**The Proposed Combination of Nagoya and Kushiya Does Not Make Claims 11-12, 43, 81, and 92-94 Obvious**

Claims 11-12, 43, 81, and 92-94 stand rejected under 35 U.S.C. § 103 as unpatentable in view of Nagoya and Kushiya ("The Role of $Cu(InGa)(SeS)_2$ Surface Layer on a Graded Band-Gap $Cu(InGa)Se_2$ Thin-Film Solar Cell Prepared by Two-Stage Method", hereinafter Kushiya).

Kushiya fails to make up for deficiencies noted above with respect to Nagoya. For example, Kushiya discloses "[a] graded band-gap structure was fabricated intentionally by selenization processes described elsewhere [6,11]. The CIGSS surface layer was prepared through the diffusion of sulfur from the surface of CIGS thin-film absorber." Page 990. The estimated thickness of the CIGSS surface layers was 60 to 80nm in the form of an abrupt grading from the surface to the bulk analyzed by XPS. Page 991.

The selenization conditions of Kushiya are such that the substrate is fully selenized, i.e. all the available binary metal selenides are reacted to form separate stable ternary alloys of $CuInSe_2$ and $CuGaSe_2$. Declaration of Vivian Alberts, Paragraph 6. Thus substantially all of the binary selenides (CuSe, InSe) are consumed. Declaration of Vivian Alberts, Paragraph 6. Thus, Kushiya fails to disclose, explicitly or inherently, a process wherein the reaction conditions are controlled such that the reaction between the group $VIA_1$ element and the metals of the mixture of the metal film is incomplete.

Applicant also disagrees with other statements by the Examiner. For example, the Examiner found that "it would have been obvious to one of ordinary skill in the art at the time of the invention to have used a molar percentage of Se of 0.05 to 0.3. One would have been so motivated to optimize device performance." Office Action, page 9. Even if the skilled artisan was motivated to form a device with a molar percentage of Se of 0.05 to 0.3, the resulting film formed by the two step processes disclosed in Nagoya and Kushiya would not have had the desired band-gap properties and would still suffer from the well known problems associated with the two step process.

Also, for substantially the same reasons discussed above with respect to Kushiya, Applicant submits that there is no reasonable expectation of success for the combination of Nagoya/Kushiya proposed by the Examiner. Applicant also submits that the recited features produced unexpected results.

For the reasons discussed above, the combination of Kushiya and Nagoya fails to disclose all of the features of independent Claims 1, 44, and 82 and their dependents. Applicant respectfully requests withdrawal of this rejection.

Further, with regards to Claim 43, Nagoya and Kushiya fail to disclose a process "such that the sulfoselenides react with the ternary alloys of step (ii) to form a third film comprising a mixture of $CuIn(Se,S)_2$ and $CuGa(Se,S)_2$". Neither Nagoya or Kushiya explicitly or inherently disclose the formation of $CuIn(Se,S)_2$ and $CuGa(Se,S)_2$". Further, the $CuIn(Se,S)_2$ and $CuGa(Se,S)_2$ can advantageously combine to form a homogenous pentenary alloy. Accordingly, Applicants request withdrawal of the rejection of Claim 43 for at least this reason.

**New Claims 95-100**

Applicant also notes that the Applicants Admitted Prior Art, Nagoya, and Kushiya fail to disclose the features of Claim 95-100. As discussed above, the cited art discloses the formation

of heterogeneous thin films with graded concentrations. Thus, the cited art fails to disclose the formation of a substantially homogenous film as claimed in Claims 95-100.

*No Disclaimers or Disavowals*

Although the present communication includes alterations to the application or claims, or characterizations of claim scope or referenced art, Applicant is not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that Applicant has made any disclaimers or disavowals of any subject matter supported by the present application.

*Co-Pending Applications of Assignee*

Applicant wishes to draw the Examiner's attention to the following co-pending applications of the present application's assignee.

| Docket No. | Serial No. | Title | Filed |
|---|---|---|---|
| DMKISCH.003APC | 10/568,229 | GROUP I-III-VI QUATERNARY OR HIGHER ALLOY SEMICONDUCTOR FILMS | 2/14/ 2006 |

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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